trated work of M. Alcide d'Orbigny, published at the expense of the French government, and for which geologists have been long waiting with impatience. During eight years of research, this gifted naturalist successively examined the coasts of Brazil, the Republic of Uruguay, the Argentine Republic from the frontiers of Paraguay to Patagonia, the coasts of Chili, Peru and Bolivia; and by a long residence in the last-named country he was enabled to survey, in many directions, a large region from the coast to the interior. The details of his labours form a first part of the work, illustrated by many sections and by one of most beautifully coloured geological maps which ever fell under my observation. In his general observations M. d'Orbigny remarks, that his own observations extend from 12° to 42° south latitude, and from 45° to 80° longitude west of Paris; a surface comprised between the coast of the Atlantic Ocean in Patagonia to Lima on the Pacific; whilst, by collecting the observations of other travellers and examining fossils from more distant localities, his general views may be said to apply to all the vast continent between Colombia on the north and the Straits of Magellan! This author reviews in chronological order the different rocks, and indicates each change which they have undergone, describing the granitic, porphyritic and trachytic masses in relation to their extension, composition and elevatory agency. He then considers in an ascending order of date the sedimentary deposits, which he classifies as *Gneissic* or Primary, Silurian, Devonian, Triassic, Cretaceous, Tertiary and Diluvial or Detrital; showing the dislocations which they have undergone at successive epochs, and the causes of these disturbances.

After an enumeration of all the facts, M. d'Orbigny, under the head of conclusions, sketches out all the great revolutions of which South America has been the scene; a subject on which he seems to display much vigour of thought, but which I cannot now attempt to analyse, without doing injustice to him, not having, in truth, had time to study his work. One only of his inferences I will advert to, as being clearly established by the order of the evidences; viz. that, as the increment of fresh matter has successively taken place from east to west, so the ancient beds of the sea have been heaved up successively on lines trending from north to south, and to the west of that primary, or original nucleus on the Brazilian shores.

Mr. Murchison next proceeds to the consideration of his subject as relating to "EASTERN COUNTRIES," inclusive of *Hindostan*, *Affghanistan*, *China* and *Egypt*, terminating the section by the following remarks relative to Egypt and Syria.

After all, it must be allowed that, with the exception of the fossil forest, and the recent elevation of her shores which separated the Mediterranean from the Red Sea, Egypt presents fewer phænomena to interest the geologist than any region of similar range over which researches have extended; for this mass of land seems to have been above the waters during the whole of the ancient periods of which other regions afford such long registers in the contents of the Palæozoic and succeeding deposits.

We have, however, but to advance northwards to the Lycian Taurus, where Mr. E. Forbes has made known to us the elevation to great heights of tertiary marine shells; or north-eastwards to Syria, where the Dead Sea, as now computed, lies upwards of 1300 feet below the level of the Mediterranean, and we are furnished with the most remarkable proofs of the mighty oscillations to which the surface has been subjected, even in recent epochs. In receding from the Mediterranean to the Dead Sea, the Lake of Tiberias marks the first depression, being 328 feet beneath the sea, and from this lake to the Dead Sea the declination is nearly 1000 feet! A few years back only and we were startled at the announcement, that the level of the Caspian Sea was 300 feet below the Mediterranean; and more accurate measurements have, indeed, reduced the depression to 82 feet; but that any cavity on a portion of the present surface should be 1300 feet beneath the level of the adjacent seas, proves an amount of vibration within a limited area, which is truly astonishing*.

PALÆONTOLOGY.

Ichthyology.—Geologists who have commenced their career since the glacial theory has been in vogue and have read the numerous memoirs and heard the exciting discussions to which it has given rise, are chiefly acquainted with Professor Agassiz as one of its most ingenious expounders. I have now the pleasure to acquaint you that M. Agassiz is once more completely absorbed in his great work on fossil fishes—that work which you so justly honoured, in the year 1835 to 1836, with your Wollaston Donation and Medal. Of his progress in this arduous undertaking, he has recently given substantial proofs, in the description of many ichthyolites of the Old Red Sandstone of Scotland; and, in addition to this, he will shortly publish a series of fossil fishes, exclusively illustrative of the tertiary basins of London and Paris, from which an enormous number of species has been collected.

In reference to the geological researches of my friends and myself in Russia, I must here state, that as it is our one great object to place in correct parallel the Palæozoic types of Russia with those of the other parts of Europe, we could not hesitate in referring all our Russian ichthyolites to Professor Agassiz; for whilst it must be acknowledged that Russia contains naturalists of great merit, and that among them M. Pander and Professor Asmus had commenced inquiries into the nature of these fossils, it was obvious that, skilful as they undoubtedly are, they could not, for want of comparisons, afford us the knowledge of which we stood in need. Pro-

* See the last discourse of Mr. W. Hamilton, the President of the Royal Geographical Society, who points out this admeasurement as being at length fixed by the admirable trigonometrical survey of Lieut. Symonds, whose calculations of 1311 feet approach very nearly to the still higher estimate of M. Berthou, who, from barometrical observations, placed it at 1332 feet.

fessor Agassiz, who has at his disposal fossil fishes from all those parts of Europe, the geological structure of which has been well explained, was alone capable of answering the following query; To what extent do the ichthyolites of Russia, which lie in beds superior to the Silurian rocks, and which are surmounted by the Carboniferous limestone, resemble those with which we are so well acquainted in Scotland and England? His reply has indeed been most satisfactory.

So complete, says he, is the identity of about ten species of the Scottish and Russian strata, that the specimens from the two countries may be confounded. Among them the *Holoptychius nobilissimus*, three species of the *Dendrodus* (Owen), *Diplopterus macrocephalus*, are forms which might strike any good observer, as they have been previously published by M. Agassiz; but from the more perfect specimens of other species which we brought from Russia, he has been enabled to recognize the presence in Scotland of the species of a common Russian genus, the *Glyptosteus*, and also of that gigantic genus the *Chelonichthys*, to whose remains I have before directed your attention as having been recognized to be of ichthyic character by Professor Asmus. To this enormous fossil fish, some of whose thoracic bones are as large as the breast-plate of a well-grown warrior, and a single bone of which measured nearly three feet in length, Professor Agassiz has given the name of *Chelonichthys Asmusii*; and he now informs me that he possesses fragments of the same creature from the north of Scotland. The knowledge of this fact will doubtless lead to redoubled activity on the part of Mr. Hugh Miller and those Scottish naturalists who inhabit the shores of the Cromarty and Murray friths, to produce a rival of the Russian giant; a hope which I cannot express without deeply lamenting the death of a most successful explorer of these remains, whose loss geologists have to deplore, in common with every one who could appreciate her range of thought, her accomplishments, and her goodness*.

The results, however, of the examination of the Russian ichthyolites go still further; for, on submitting to the microscope of Professor Owen some teeth similar in outline to those of his genus *Dendrodus*, he discovered in them precisely the same dendridic disposition of the vascular canals as that which led him to establish the genus from Scottish fossils. Nor does the value of this application of the microscope stop here, for Professor Agassiz has informed me, that availing himself of the weapons which Professor Owen had so skilfully wielded, he has commenced a series of researches, not only into the teeth but also into the structure of all the hard enamelled bones of the Russian fossil fishes, by which he will be able to show the same distinction in the other bones of the genera of this class, which Professor Owen has successfully established in relation to the hard parts of the higher order of animals. In such hands, therefore, the microscope has become an instrument of great utility in identifying fragments apparently obscure; and, as it has been applied to the shells of Mollusca, and even to the lowest links in animal life, as well as to fossil plants, the geologist has thus acquired a new and powerful auxiliary. I am here, however, treading on ground now fortunately occupied by the Microscopical Society, the active promoters of which are well entitled to our gratitude.

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* Lady Gordon Cumming.

Ornithichnites.—To American geologists we are indebted for our acquaintance with this new class of phænomena. The existence of the fossil bones of birds of ordinary size had, it is true, been ascertained by Dr. Mantell in the Wealden strata, but great was our astonishment, and I may add our incredulity, when Professor Hitchcock first announced, that in rocks of considerable antiquity (the exact age of which is still uncertain), there existed innumerable impressions in successive layers, which must have been formed by birds, some of them of gigantic size, and to which he boldly assigned the name of "Ornithichnites." Various opinions were entertained, and much scepticism prevailed concerning these impressions; but it is due to Dr. Buckland to state, that he never doubted that the views of Professor Hitchcock were founded on true natural analogies, and he accordingly published this opinion, with illustrative plates, in his Bridgewater Treatise. The recent visit of Mr. Lyell to North America, and a memoir he has read, as well as a communication from Dr. James Deane of Massachusets, have necessarily brought this highly interesting subject again before us; whilst a very remarkable discovery in natural history has at all events almost entirely dispelled scepticism regarding the true *bird-like character* of even the largest of the footsteps, however difficult it may be to imagine the presence of such highly organized creatures at a very early period. The observations of Mr. Lyell completely support the views of Professor Hitchcock as to the littoral nature of the footstep deposit in Connecticut, and that the prints in question were left by birds on the mud and sand of former estuaries, the bottoms of which were gradually submerged, and by the increase of fresh matter were permanently preserved.

Mr. Lyell illustrates the ancient phænomena by reference to impressions which he saw forming at low water on the mud of the sea shore of Georgia by racoons and opossums, and covered by blue sand before the flow of the tide, as well as by the recent footsteps of birds in the red mud of the Bay of Fundy, which if submerged would realize a complete analogy to the fossil footsteps through many successive laminæ of deposit*. He also believes with Professor Hitchcock, that the strata in question had been elevated and tilted since their original deposition, and he connected these movements with the evolution of trappean rocks, which in some places invade the Ornithichnite beds. In regard to the age of these beds no decisive opinion has yet been expressed, though they are referred to one of the older secondary rocks. However this point may be determined, and I will presently allude to it, the great question remained to be settled; how induce us to believe that the largest of these footmarks were made by birds? Is it not unsafe to call in the presence of creatures of such high organization when researches all over the world have taught us that in rocks of far less antiquity no traces of the bone of a bird or mammal have been found? May not the impressions after all be those of some singular Sauroid animal with trifid feet, of which we have no links in existing nature? Looking to such a possible explanation, and reflecting on the striking interference with the opinion heretofore very generally received, that a succession from lower to higher orders of creatures was invariably evidenced in ascending from lower to higher deposits, I candidly confess, that nearly up to the present moment, despite of the clear and faithful descriptions of the facts, I have clung to the idea, that the markings would not eventually be referred to the action of birds. My scruples as a geologist have, however, I confess, been much shaken, if not entirely removed, by a discovery in natural history, which I do not hesitate in characterizing as one of the most remarkable of modern times.

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* A striking explanation of appearances, respecting which we were at first equally incredulous when pointed out on the surface of the Red Sandstone of England as fossil rain-drops, is given by Mr. Lyell in the actual formation of similar markings produced by rain on the mud of the shores of Long Island.

From the examination, in 1839, of a single fragment of a bone brought from New Zealand, Professor Owen, though at first startled by its enormous size, at length pronounced it to belong to a gigantic form of the lowest organized bird, analogous to the diminutive Apteryx of the same island, in which the lungs approach more closely than in any other bird to the structure of those in reptiles. To this monstrous winged animal he assigned the name of *Dinornis*, and many of its bones, in a very perfect condition, having been subsequently found in New Zealand and deposited in the museum of the College of Surgeons, his opinion has been completely confirmed*. When it is known that the tibia of this bird is so huge that the femur of the Irish giant is of pigmy dimensions when compared with it, some conception may be formed of its entire size, which must have far exceeded that of the ostrich†.

Now to apply this discovery to our Ornithichnites, one of the great difficulties which many of us had to overcome was the gigantic size of the largest American footsteps, which measured fifteen inches in length; and it is a most curious fact, that upon placing the fossil cast alongside of the metatarsal bone and tibia of the largest individual of Dinornis, Professor Owen is of opinion, that if the feet of this great tridactyle bird be found, they will, from the usual proportions maintained in such animals, be fully as large as those of the American Ornithichnite. From this moment, then, I am prepared to admit the value of the reasoning of Dr. Hitchcock, and of the original discoverer, Dr. James Deane, who it appears, by the clear and modest paper lately brought before us by Dr. Mantell, was the first person who called the Professor's attention to the phænomenon, expressing then his own belief, from what he saw in existing nature, that the footmarks were made by birds. Let us now hope, therefore, that the last vestiges of doubt may be removed by the discovery of the bones of some fossil Dinornis; and in the meantime let us honour the great moral courage exhibited by Professor Hitchcock, in throwing down his opinions before an incredulous public*.

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* The inhabitants of New Zealand believe that the Dinornis was in existence with their progenitors. On this point, however, doubts may still be entertained, as we know that in many uncivilized countries, where the bones of extinct quadrupeds occur, the natives connect them with their ancestors.

† See a most graphic sketch of this monstrous bird and its analogies from the pen of my friend Mr. Broderip, Penny Cyclopædia (*Unau*).

Still, however, comes the question, what is the age of the rock on which the Ornithichnites have been impressed. Consulting what Mr. Lyell has recently written, we find that he does not decide this point further than by saying, that they were formed between the carboniferous and cretaceous epochs, the only remains hitherto found in the deposit being ichthyolites of the genera Palæoniscus and Catopterus, with some fossil wood. The presence of a Palæoniscus would lead me to suspect that the deposit might be of the age of the Zechstein or Magnesian Limestone; for in Russia, wherever the calcareous matter which represents that rock thins out, vast tracts are occupied by marls, sandstones and conglomerates of red, green and white colours, which form the Permian system, and in these beds Palæonisci occur. If the fossil fishes from both localities be placed in the hands of Professor Agassiz, and a comparison be made of the fossil wood from Russia and North America, the query may be satisfactorily answered. In the meantime I cannot read the descriptions of this American deposit, and carry the Russian types in my recollection, without surmising, that in the sequel the Ornithichnite and Palæoniscus beds of Connecticut and the gypsiferous rocks of Nova Scotia, distant as they are from each other, will be found to belong to one natural group—the Permian; and if this view be borne out, it follows that a bird analogous to the Dinornis lived at a period when Saurian animals first began to appear upon the surface, and when the last links of primæval or palæozoic life were not obliterated†. In this case the value of the philosophic caution given by Mr. Lyell will be very apparent, viz. that we ought not to infer the non-existence of land animals from the absence of their remains in contemporaneous marine strata‡.

Saurians, Cetaceans, &c.—I am not aware that researches of the past year have added much to our acquaintance with new forms of vertebrata in the secondary deposits, though it must not be unrecorded, that our zealous contributor M. Hermann Von Meyer, has added to the list of Saurians of the Muschelkalk a new genus, which he describes under the name of Simosaurus.

In Russia a very curious discovery has been made by Professor

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* See Geol. Proceedings, January 1843, Dr. James Deane 'On Ornithoidicnites.' [An abstract of this paper will appear in a future Number of Phil. Mag.]

† This view has been strengthened by the researches of Mr. Logan, see note, p. 546.

‡ Geol. Proceedings, vol. iii. p. 796.

Brandt, of which I have been just informed by my friend Count Keyserling. Pallas had spoken of a locality among the cliffs of Taman, in the southern steppes, where remains of whales were found; Rathke had mentioned the head of an animal of which the vertebræ were known, and which he described as approaching to a whale; and more recently Professor Eichwald considered this fossil as belonging to the Dolphins and named it *Xiphias priscus.* Obtaining possession of the specimen for the museum of St. Petersburgh, Professor Brandt worked the head of the colossal creature out of the rock in which it was imbedded, and pronouncing it to belong to a new family of whales, described it under the name of *Cetotherium Rathkii.* This fossil whale forms a new link in the animal kingdom, and is more nearly allied to the herbivorous cetaceans than to the Dolphins. Its position in the geological series is also most remarkable; for the rock in which it occurs contains shells similar to those of the tertiary deposits of the Miocene age, which extend from Volhynia and Podolia to the Crimea and Taman. It is also very remarkable, that along with this herbivorous cetacean the other organic remains (among which, however, banks of corals occur) have more the character of the inhabitants of a brackish sea than those of the subjacent rocks, whose fauna more resembles that of the Black Sea and the Mediterranean.

These relations are in accordance with modern conditions, and are, indeed, explained by an analogy in our own country, for an acquaintance with which I am indebted to our Curator, Mr. E. Forbes. The lake of Stennis, in the Orkney Islands, celebrated by Sir Walter Scott, has been converted, whether by elevation of the land or other cause, from a saltwater loch into a freshwater and marshy tract, and with this great but gradual change, certain marine genera have continued to live on amid their new associates of land and fresh water, whilst others have perished. That which is taught on a small scale in the Scottish lake has occurred over a vast area in the case of the Caspian Sea; which, in consequence of separation from the Black Sea has passed into a brackish state, and the same hardy and time-serving marine genera as in Scotland have continued to exist in their new abode! The Miocene deposit of Taman, therefore, with its herbivorous cetaceans, brackish and marine shells, is only an example, in an earlier period of the world, of the formation of a true Caspian, the creatures in which necessarily differed from those of the pure marine period which went before them.

MASTODONTOID AND MEGATHERIOID ANIMALS.

For a season our metropolis contained within it a magnificent skeleton of a Mastodontoid quadruped, which, in common with all geologists and palæontologists, I hoped to see permanently established in our national Museum. This gigantic animal was discovered by a persevering Prussian collector, M. Koch, who for some time resided in the United States, and who disinterred it, together with a great profusion of heads, teeth, and numerous bones of similar animals, from amid the alluvia of a tributary of the St. Louis river, where the chief remains had probably been an object of superstitious tradition on the part of the Indian tribes. It does not appear whether the zealous Prussian had any scruples to overcome; but I presume they must have been considerable, if I were to judge from my own experience in other wild countries. In travelling along the eastern flanks of the Ural Mountains, it was my lot to visit many sites of gold alluvia in which bones of the mammoth and other extinct quadrupeds are found, and for these remains the poor Bashkirs, the original inhabitants of the tract, preserved so deep a veneration, that in freely permitting the search after the true wealth of their country which they were incapable of extracting, their sole appeal to the Russian miners was, "Take from us our gold, but for God's sake leave us our ancestors."

Overcoming, however, all difficulties, M. Koch succeeded in extracting, and afterwards in setting up, the most complete specimen of the species which has ever been seen. Applying to it the provisional name of "Missourium," he exhibited it for some time in the United States, and then brought it with many of the associated bones to London, in the hopes both of having the remains perfectly described and of obtaining for them a price worthy of the British nation.

The arrival of such a collection could not fail to excite the most lively interest and curiosity among our naturalists, and the bones having been attentively examined by many members of this Society, produced a diversity of opinion respecting the generic character of the chief remains. North America had long been a fertile mine of such reliquiæ, and the naturalists of the United States had not been backward in studying and describing them. It is not, therefore, a little remarkable that the same difference of opinion as to the generic and specific identity of the animals that prevailed across the Atlantic, is presented in the Memoirs which have recently been read before us; Dr. Harlan and Mr. Cooper having maintained opinions, with which, to a great extent, Professor Owen concurs, whilst Dr. Grant and M. Koch have supported the views of the late Dr. Godman.

Citing the American authorities on his side of the question, including Dr. Hayes, and enumerating no less than thirteen species of Mastodon and six species of Tetracaulodon, Dr. Grant has made a vigorous effort to vindicate the true generic characters of the Tetracaulodon as founded on the presence of a tusk or tusks in the lower jaw and certain variations in the form of the crowns of the molar teeth.

This view has been sustained by Mr. A. Nasmyth in an elaborate paper "On the Minute Structure of the tusks of extinct Mastodontoid animals." Microscopical examination of portions of the tusks believed to belong to five distinct species, viz. *Mastodon giganteus, Tetracaulodon Godmani, T. Kochii, T. Tapiroides* and the *Missourium*, has also led this author to the same inference as Dr. Grant; and he concludes with the remark, that, if it be established that specific differences positively do exist among all these animals, the value of such microscopic researches is great; but if the five animals are grouped as one, then such mode of observation is of no value in palæontological science.

Professor Owen had previously expressed opinions at variance with those of Drs. Hayes, Godman and Grant and Mr. Nasmyth, and his views have been supported within these walls by my predecessor, Dr. Buckland. Pointing out certain mistakes in the setting up of the Missourium, as exhibited in the Egyptian Hall, he compares the fossil with all forms with which he was acquainted; and, showing that it must have belonged to the Ungulata, he judges that the enormous tusks of the upper jaw constitute it a member of the proboscidian group of pachyderms, and that the molar teeth prove it to be identical with *Tetracaulodon* or *Mastodon giganteus.* He argues that the genus Tetracaulodon was erroneously founded upon dental appearances in the lower jaw of a very young proboscidian, and that Mr. W. Cooper was correct in suggesting that the Tetracaulodon was nothing but the young of the gigantic Mastodon, the tusks of which were lost as the animal advanced in age. A comparison of the whole of M. Koch's collection produced the result in Mr. Owen's mind, that, with the exception of a few bones of the *Elephas primigenius* (Mammoth), all the other remains of proboscidean pachyderms in it belong to the *Mastodon giganteus.* The remains of other animals found by M. Koch are referred by the Hunterian Professor to *Lophiodon*, *Mylodon Harlani*, *Bos*, *Cervus*, &c.; and in respect to the *Mastodon giganteus* he expresses his conviction that it had two lower tusks originally in both sexes, and retained the right lower tusk only in the adult male. Although unable to form a correct judgement on the probable structure of those extinct quadrupeds, I may call your attention to a recent work of Mr. Kaup, whose striking discovery of the Deinotherium is familiar to you, and who now seems to advocate, from perfectly independent sources of evidence, the same views as Professor Owen concerning the osteology and generic characters of the Mastodon founded upon the comparison of a series of bones and teeth belonging to the *Mastodon longirostris*, more numerous and complete than even those of the *Mastodon giganteus*.

Mylodon.—One of the most brilliant, and, I venture to say, not the least durable of the researches in palæontology, remains to be mentioned in the description of the *Mylodon robustus*, a new species of gigantic edentate animal, accompanied by observations on the affinities and habits of all Megatherioid animals. After a sketch of the labours of Cuvier, who first described the huge Megatherium and pointed out its analogy to the family of Sloths and Armadillos, of the succeeding writings of Jefferson and Harlan upon the genus Megalonyx, of Dr. Lund on the Cœlodon and Sphenodon of Brazil, and of his own researches which established the Mylodon and Scelidotherium, Professor Owen proceeds to describe the megatherioid animal which he has named *Mylodon robustus*.

Of the purely anatomical descriptions, it is not my province to speak, and referring you to the work in which, through the enlightened munificence of the College of Surgeons, all the necessary illustrations have appeared, I pass to the generalizations, and learn that the Mylodon, in common with the Megatherium and Megalonyx, are genera of the family of *Gravigrada*, as distinguished from the *Tardigrada* in the order *Bruta*.

Professor Owen then proceeds to a comparison of the anatomy of the Mylodon with that of all analogous creatures, and after an able analysis, he satisfies himself, and also, I am persuaded, every one who has followed his close reasoning, that he has at length ascertained the true habits and food of this family of mammifers. From their dentition, it is inferred that the Megatherium and Mylodon must have been phyllophagous, or leaf-eating animals; whilst, from their short necks, the very opposite extreme to the camelopard, they never could have reached the tops of even the lowest trees. Cuvier, on the contrary, suggested that they were fossorial, or digging animals; and we all recollect the animated manner in which Dr. Buckland attracted us, whilst he described the Megatherium as a huge beast, which, resting upon three legs, employed one of its long fore-hands in grubbing up whole fields of esculent roots; a habit which procured for it the significant popular name of "Old Scratch."

Dr. Lund, a Danish naturalist, had considered the Megatherium to be a scansorial or climbing animal; in short, a gigantic Sloth. After a multitude of comparisons, Professor Owen rejects the explanation of all his predecessors. He shows that the monstrous dimensions of the pelvis and sacrum, and the colossal and heavy hinder legs, could never have been designed, either to support an animal which simply scratched the earth for food, or one which fed by climbing into lofty trees, like the diminutive Sloth; and he further cites the structure of every analogous creature, either of burrowing or climbing habits, to prove, that in all such the hinder legs are comparatively light. What then was the method by which these extraordinary monsters obtained their great supplies of food? The osteology of the fore-arm has, it appears, afforded answers which are valuable, chiefly for their negation of erroneous conjectures, such as that the animal was an ant-eater, rather than for the habits which it directly elicits. It is, therefore, to the organization of the hinder limbs that Professor Owen mainly appeals to ascertain the functions of the forefeet and the general habits of the Mylodon.

Arguing that the enormous pelvis must have been the centre whence muscular masses of unwonted force diverged to act upon the trunk, tail and hind-legs, the latter, it is supposed, formed with the tail a tripod on which the animal sat. Professor Owen supposes that the animal first cleared away the earth from the roots with its digging instruments, and that then seated on its hinder extremities, which with the tail are conjectured to have formed a tripod, and aided by the extraordinary long heel as with a lever, it grasped the trunk of the tree with its forelegs. Heaving to and fro the stateliest trees of primæval forests, and wrenching them from their hold, he at length prostrated them by his side, and then regaled himself for several days on their choicest leaves and branches, which till then had been far beyond reach. After showing that from the natural inversion of the hind-feet the Mylodon approached to the scansorial animals, and thence inferring that it might have had climbing powers necessarily much limited by the other parts of its frame, Professor Owen states, that the inversion of the soles of the feet is least conspicuous in the Megatherium, whose bulk and strength would be adequate to the prostration of trees too large for the efforts of the Mylodon, Megalonyx and Scelidotherium. The Megatherium, in short, was the mighty tree-drawer, and had therefore no need of the adventitious aid of any climbing apparatus. Allow me to add, that, amongst other reasonings, those which lead to conclusions that one class of megatherioid animals was furnished with a hairy coating (like the Mylodon), whilst another, like the great Megatherium, was devoid of it, as evidenced by slight modifications of the bony structure of the hind-feet, appear to me to be not the least original and interesting.

Wholly incapable, as I am, to do justice to this masterly inquiry by the necessarily brief allusion which is imposed upon me by the nature of this discourse, I shall best execute my task in quoting the words with which Professor Owen sums up his reasoning.

" On the Newtonian rule, therefore, this theory has the best claim to acceptance ; it is, moreover, strictly in accordance with, as it has been suggested by, the ascertained anatomy of the very remarkable extinct animals, whose business in a former world it professes to explain. And the results of the foregoing examination, comparisons and reasonings on the fossils proposed to be described, may be summed up as follows. All the characteristics which exist in the skeleton of the Mylodon and Megatherium, conduce and concur to the production of the forces requisite for uprooting and prostrating trees; of which characteristics, if *any one were wanting, the effect could not be produced*: this, therefore, and no other mode of obtaining food, is the condition of the sum of such characteristics, and of the concourse of so great forces in one and the same animal."

This, Gentlemen, is the true Cuvierian style, in which, as in numberless parts of his works, Professor Owen has continued to breathe out the very spirit of the founder of palæontological science.

It is by such labours that geology is steadily gaining a higher place among the sciences. Comparative anatomy has truly been our steadiest auxiliary, and well may we do honour to those who impart to us such truthful records; for, whilst the histories of the earlier beings of our own race are shrouded in obscurity, whilst the first chronicles of ancient Rome and Greece are now admitted to be exaggerated, and often even fabulous, we turn back the leaves of far more antique lore; and, not trusting to perishing inscriptions, mutilated by successive conquerors, and assuming a hundred meanings under the eyes of doubting antiquaries, we appeal only to the proofs in nature's book, and find that their reading is pregnant with evidences which must be true, because they are founded on unerring general laws.

In concluding this Address, I can assure you, Gentlemen, that, although not prepared without some labour, its composition has afforded me both gratification and instruction. Had I not felt a strong obligation to fulfil my duty, I should necessarily have been absorbed in the preparation of the work upon Russia to which I have alluded, and could not therefore have been imbued with an adequate sense of the vast progress which our science has recently made in all quarters of the globe.

The chief aim of this Society has been to gather sound data for classification; and, following out this principle, I have endeavoured to show, how the order of succession established in our own isles, is now extended eastwards to the confines of Asia, and westwards to the back-woods of America. From such researches, and by contributions from our widely spread colonies, we have at length reached nearly all the great terms of general comparison.

Besides ascertaining where the great masses of combustible matter lie, we can now affirm, that during the earliest period of life, conditions prevailed, indicating a prevalence over enormous spaces —if not almost universally—of the same climate, involving a very wide diffusion of similar inhabitants of the ocean. We have learned, that in the earliest of these stages of animal life, no vestige of the vertebrata has yet been found, whilst in the succeeding epochs of the Palæozoic age singular fishes appear, which, in proportion to their antiquity, are more removed from all modern analogies. In each of these early and long-continued periods, the shells preserving on the whole a community of character, differ from each other in each division—and in that later formation, where a very few only of the same types are visible, they are linked on to a new class of beings, the first created of those Saurians, whose existence is prolonged throughout the whole Secondary period; whilst we have this year seen reason to admit that even birds (some of them of gigantic size) may have been the cotemporaries of the first great lizards. With the close of the Palæozoic æra we have also observed a gradual change in the plants of the older lands, and that the rank and tropical vegetation of the Carboniferous epoch is succeeded by a peculiar flora. In the next, or Triassic period, we have another flora, whilst new forms of fishes and mollusks indicate an approach to that period when the seas were tenanted by Belemnites and Ammonites, marking so broadly these secondary deposits with which British geologists have long been familiar, and which, commencing with the Lias, terminate with the Chalk. And lastly, from the dawn of existing races, we ascend through successive deposits gradually becoming more analogous to those of the present day, until at length we reach the bottoms of oceans so recently desiccated, that their shelly remains are undistinguishable from those now associated with Man, the last created in this long chain of animal life in which scarcely a link is wanting!—all bespeaking a perfection and grandeur of design, in contemplating which we are lost in admiration of creative power.

Such results, grand as they are—nothing less in short than the records of creation—are however but a portion of the labours of geologists. They have also struggled to explain the causes of those great revolutions. In some continents, it is true, the pages in the book of nature are, as it were, unruffled; for, by whatever agency effected, it is certain that beds of vast ancient oceans have been so equably elevated and depressed, and again so steadily elevated from beneath the sea, that the continuity of their rocky deposits over areas larger than our kingdoms of Western Europe is unbroken, and their original condition almost entirely preserved. In other regions, on the contrary, the sediments in the sea and the masses of the land have been pierced by numerous outbursts of igneous and gaseous matters, accompanied by violent oscillations and breaks, whereby the chronicles of succession have been sorely defaced, and often rendered more illegible than the most carbonized of the papyri found under the lava of Vesuvius. Nay, so intensely has this metamorphism operated, that obliterating all vestiges of former life, and concealing them from us, we have been sorely puzzled to ascertain by what powerful physical agency such mighty changes can have been accomplished,—changes by which the strata have been convoluted into forms grotesque as the serpent's coil, inverted in their order, or shivered into party-coloured and crystalline fragments. And yet in these broken and mineralized masses, as another branch of our science teaches, are found the precious ores and the metals most useful to mankind.

Such complicated relations and such changes in original structure call forth the application of the highest powers of physical science; not only involving the agency of that great central heat, to which geologists have willingly referred, but also invoking the aid of agents, some of them still mysterious, by which electricity and magnetism are bound together in the cycle of terrestrial phænomena. To few of us is it given to venture with firm steps into that region; and, though I hope to live to see some of these questions answered, I am well satisfied to have been among you when such solid advances have been made, in deciphering the mutations of the surface of the earth, and in the compilation of a true history of its earlier inhabitants.

Having now, Gentlemen, completed the term of my service, I bid you farewell, as friends in whose society, whilst acquiring knowledge, I have passed the happiest days of my life. Large as our numbers are, and branching out, as our inquiries do, into all the paths of philosophic research, the Geological Society has always held firmly together by a principle of good and high feeling among its active members. I have, indeed, deeply felt the honour of presiding over men who, in the course of a quarter of a century, have demonstrated, that there is no such thing as "*odium geologicum*," and whose members, rivals as they must be, have only sought to excel each other in their ardent search after truth.

By the choice of my successor you cannot fail to perpetuate this good feeling, for in him you recognize the philosopher, who, passing through other phases, returns to the object of his first love. In him you applaud one of the founders of your Society, a munificent supporter of geological works requiring assistance, one of your earliest contributors, and one, I will add, of the best Secretaries you ever had—whether as respected the performance of his own duties or the singleness of mind and integrity of purpose with which, abjuring all personal considerations, he improved the Memoirs of various writers which found their way into your Transactions. His fitting reward, therefore, is this Chair, which I resign to him in the full persuasion that he will view it, as I have done, in the light of the highest honour to which a geologist can aspire; and that as one of our old and sincere friends, he will ever be imbued with the strongest motives for preserving the harmony and prosperity of the Geological Society.

ROYAL ASTRONOMICAL SOCIETY.

March 10, 1843.—The following communications were read:—

1. Occultations observed at Port Royal Dockyard, Jamaica. By Capt. Alexander Milne, H.M.S. Crocodile. Communicated by the Rev. Geo. Fisher.

2. Observations of the Beginning and End of the Solar Eclipse on the 8th of July, 1842. In the Fort of the left bank of the Shanghaie River, near to the Town of Woosung, on the Coast of China. By Capt. Sir Everard Home, Bart., F.R.S., H.M. Ship North Star. Communicated by the Rev. Geo. Fisher.

The observations contained in these two communications are stated in the Monthly Notices of the Society, No. 29 of vol. v.

3. Translation of a Letter from M. Hansen to R. W. Rothman, Esq., accompanying a copy of a printed paper on the Perturbations of the Heavenly Bodies moving in very Eccentric and very Inclined Orbits.

"Sir,—I have the honour to send you herewith the abstract of a memoir in which I have developed a method for calculating the perturbations of those celestial bodies which move in very eccentric and very inclined orbits. I beg you to forward this abstract to the Royal Astronomical Society. In this memoir I have treated only the case in which r is less than r', and I have simply adverted to the case in which r is greater than r' That I may be better understood, I add here that, in this case, it is the true anomaly of the perturbed body which must be employed. The integration is performed in this case in an analogous manner; but we cannot make the factors of integration depend on continued fractions: those factors depend in this case on a linear differential equation of the first order.

"Gotha, March 1, 1843." "P. A. Hansen."

4. On the Application of the Method of Least Squares to the Determination of the most probable Errors of Observation in a portion of the Ordnance Survey of England. By Thomas Galloway, Esq., A.M., F.R.S., one of the Secretaries of the Society.

The object of this communication is to give the results of an application to a part of the Ordnance Survey, of a general method of correcting the observed horizontal angles, whereby the positions of the stations are determined in such a manner as to give the nearest, or most probably accurate, representation of the whole of the observations. The method in question, which is due to Gauss and Bessel, has only recently been introduced into geodesy. In all the geodetical measurements which were executed prior to the latter part of the last century, the errors of observation were of such magnitude that it was unnecessary to take account of the curvature of the earth, and the triangles were accordingly computed as if they had been on a plane surface. On this hypothesis the sum of the three angles of each triangle is 180°; and as the strict fulfilment of this condition is necessary for the computation of the triangles, the universal practice was to apply arbitrary corrections to the observed angles, the observer usually assigning the largest correction to the angle which he *supposed* most likely to be erroneous. The large and excellent theodolite used by General Roy in his triangulation (begun in 1784) for connecting the observatory of Greenwich with the meridian of Paris, and the repeating circle of Borda, introduced about the same time on the Continent, gave the means of measuring terrestrial angles with far greater precision than had been obtained with the old quadrants, and the curvature of the earth became a necessary element in ascertaining the amount of the errors of observation. No alteration was, however, required on this account in the mode of correcting the angles, for as the *spherical excess* can be computed from approximate values of the sides to any required degree of exactness, the condition necessary for the computation of an individual triangle was still that the sum of the three horizontal angles should be equal to a known quantity; and in all the principal trigonometrical operations of which accounts have been published (excepting Colonel Everest's prolongation of the Indian arc of meridian, and some recent surveys in Germany), this condition (speaking generally) is the only one which has been attempted to be satisfied in computing the observations. But the observance of this single condition is not by any means sufficient to give the best representation of the *whole* of the observations: nor does it even suffice to give a determinate solution of the problem under consideration, for when the distance between two stations is computed through different series of triangles, each mode of computing leads to a different result. When the instrument has been set up at every station, and the angles between the other stations visible from that point have been all observed, other geometrical relations are established which the corrected angles ought likewise to satisfy, and angles are obtained which cannot be made use of otherwise than in satisfying such relations. Now, it is manifest that any mode of computing the triangles in which any observed angle is not taken account of, or any geometrical relation among the parts of the figure not satisfied, or which does not allow to every single observation its due influence, cannot be regarded as satisfactory. In order to obtain the nearest representation of the whole of the observations, or the result which is affected by the smallest probable error, it is necessary to solve the following problem, viz. to determine the corrections which must be applied to the observed angles in order that they may satisfy *all* the geometrical relations or equations of condition, and in order that the sum of the squares of the corrections may be an absolute minimum. A general solution of this problem was given by Gauss in his *Supplementum Theoriæ Combinationis*, &c. (Gottingen, 1828), and the method has been applied by Bessel to the triangulation for the measure of the meridional degree in Prussia, and also to the computation of the extension of the French meridian through Spain, from Montjouy to Formentera.

The triangulation which has been selected in the present case for an example of the method, includes ten stations (commencing with the base on Hounslow Heath), at which thirty-five independent angles were observed. For determining the corrections of those angles, nineteen equations of condition are furnished by the observations, among which are instances of all the kinds which can occur in a trigonometrical survey. The final results differ extremely little from those given in the Survey, the greatest difference in the length of any side amounting only to about half a foot, and this in a distance of nearly eighteen miles. This close agreement must be attributed, however, to the smallness of the triangles, and the very great accuracy of the observations in this portion of the Ordnance Survey. If the distances between the stations had been two or three times greater, the observations would probably have been less exact, and the differences between the results of the two methods of computation more considerable; but however this may be, it is only by following the method here explained that the whole of the precision which is attained by the observations is preserved in the results; and for this reason the method should be adopted in all important surveys, particularly in those for determining the curvature of the earth. Besides giving a determinate result, and that result the one which is most probably nearest the truth, it has the great advantage of superseding all arbitrary corrections, and admitting only such as are rigorously deduced from the observations.

The methods of deducing the most probable values of the angles from the observations, of assigning the weights, of forming the equations of condition, and all the steps of the process to the final determination of the corrections by which the equations are satisfied, are given at length.

5. The President announced a communication that he had received from the Rev. Baden Powell, relative to an easy and convenient method of imitating the appearance of the *corona*, or glory, that surrounds the body of the moon, during the time of total darkness, in total eclipses of the sun; and also the appearance of the *beads* that occur not only in total eclipses, just prior to the time of total darkness, but likewise in annular solar eclipses. A sketch of the method was exhibited, which is merely this: a candle is placed in the focus of a lens fixed in a screen, with an aperture of about $\frac{3}{4}$ths of an inch in diameter, on the opposite side of which screen is placed an opake circular disc, of equal (or even greater) diameter than the aperture, which may be placed at different distances, so as to produce an eclipse of any magnitude, as the spectator shifts his position. When it is central and total, there is a brilliant ring, or glory, even when it is so much nearer to the eye as to subtend a much greater angle than the aperture. Also, when there are any cusps, minute irre-

gularities, on the edge of the disc, produce distinct *beads*. Professor Powell has tried a similar experiment with the circular opake disc and the rays of the *sun* reflected from a small piece of glass, which produced a most brilliant ring, the disc being nearly double the apparent diameter of the sun: and he proposes to pursue the inquiry still further.

MEETING OF THE ROYAL INSTITUTION.

Friday, June 9, 1843.

The lecture was by Professor Faraday, on the "Electricity of Steam." The Professor commenced his lecture by illustrating the extent of our knowledge of the electricity which accompanies the formation of steam previous to the observations about to be detailed, showing that when water is poured into a heated metal cup electricity was set free; and that if the vessel, into which the water was placed, was above a certain elevated temperature, no electricity was evolved in consequence of the water being prevented from contact with the containing vessel by a stratum of steam. The Professor then detailed the first observations made at Newcastle by one of the workmen in attendance on a boiler belonging to the Newcastle and Carlisle Railway, and whose report, that the boiler was full of fire, from the fact that when he placed his hand near it an electric spark was communicated, drew the attention of Mr. Armstrong to the subject, the result of whose investigations was then given. A boiler having been arranged for the purpose of illustrating this subject, the Professor exhibited the production of the spark during the emission of the steam, and showed most conclusively that the boiler and appendages were charged with negative electricity, while the issuing steam was in the opposite or positive state; that it was necessary that the boiler should be insulated; that the steam should issue through a small aperture; that the material of which this aperture was constructed modified materially the quantity of electricity, wood and the metals having been found by experiment to be the best fitted for the purpose; that the introduction of a small portion of saline matter, as sulphate of soda, into the exit chamber prevented entirely the elimination of electricity, and even when common water was introduced it had the same effect; that by long continuance of the issuing current of steam, electricity was gradually developed, from the condensed steam displacing and driving out the saline matter, pure water being a necessary element for its production; and that the whole phænomena arose from the rubbing of the condensed water against the tube from which the steam was issuing. The Professor also proved that the introduction of ammonia reversed the electrical states, what was before negative becoming positive, and that as the ammonia was expelled the original states were gradually restored; that turpentine and acids acted in the same way as saline substances, from their enveloping the particles of water in a film of their own substance. The lecturer considered, from these facts, that the view advocated by Mr. Armstrong, that the electricity arose from the passage of water into the aeriform state, was not tenable, and that the thunder-cloud and the lightning's flash could not be attributed to this origin.

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Fig. 3.

TRANSVERSE SECTION

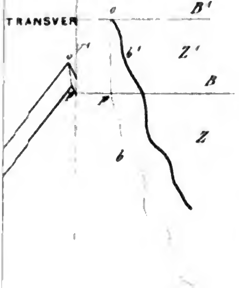


Fig. 1

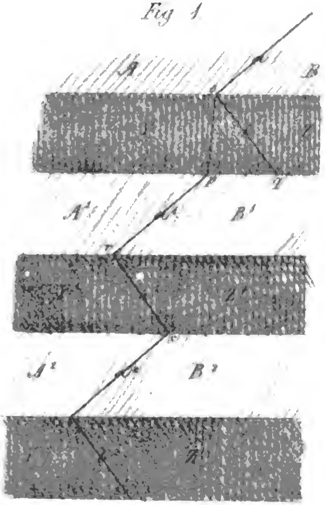


Fig. 4.

TRANSVERSE SECTION

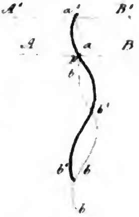
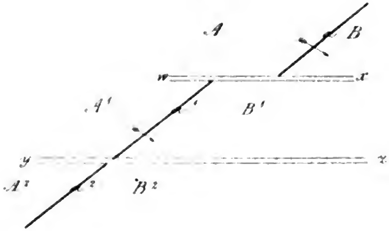


Fig. 2

PLAN



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